



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A23B 7/10, 7/148, 7/06	A1	(11) International Publication Number: WO 93/19609 (43) International Publication Date: 14 October 1993 (14.10.93)
(21) International Application Number: PCT/GB93/00691 (22) International Filing Date: 2 April 1993 (02.04.93) (30) Priority data: 9207344.4 3 April 1992 (03.04.92) GB (71) Applicant (for all designated States except US): VETOSTAR LIMITED [GB/GB]; 52 Downham Road, Watlington, King's Lynn, Norfolk PE33 0HS (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): HOWARD, John, George [GB/GB]; 52 Downham Road, Watlington, King's Lynn, Norfolk PE33 0HS (GB). (74) Agents: SPENCER, Graham, Easdale et al.; A.A. Thornton & Co., Northumberland House, 303-306 High Holborn, London WC1V 7LE (GB).		(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: TREATMENT OF VEGETABLE FOODSTUFFS FOR PRESERVATION (57) Abstract Vegetable foodstuffs such as potatoes, beetroot, carrots and other root vegetables, are preserved by treating with a non-toxic food acid solution of pH 3.8 or less, and then sealing in a container, the treated foodstuff having been sterilised by heat and having been blanched. The pH of the treated foodstuff is no more than about 4.8.		

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TREATMENT OF VEGETABLE FOODSTUFFS FOR PRESERVATION

This invention relates to a method of treating vegetable foodstuffs to preserve them, and to hermetically sealed containers of vegetable so treated.

Raw vegetables are usually preserved by freezing or chilling, in which case the foodstuff is not sterile, or by canning which involves sterilization by heat and leaves the product in a more or less cooked state. These methods are all energy intensive, and freezing or canning may require high initial expenditure on equipment. The generally preferred method, freezing, not only requires initial expenditure and a great deal of energy for the preliminary treatment, but the frozen product must be transported and stored in a frozen condition. This requires a continual energy input which is expensive. In the canning of vegetables, it is necessary to add a covering liquid, usually brine, to the vegetables before processing. This represents approximately 35% of the volume and weight of the container, which adds to storage and distribution costs. The brine is of no value to the consumer of the vegetables.

A number of methods of treating vegetable foodstuffs have been proposed. For example, United States patents nos. 2620277, 3959501, 4097612 and 4579743, European patent specification no. 0 006 067, French patents nos. 72.23697 and 75.14327, Belgian patent no. 545875, and U.K. patents nos. 2059248 and 2174588 all include the use of sulphur dioxide in the treatment for its anti-oxidant and

bactericidal properties. The use of sulphur dioxide in foodstuffs is not permitted in Japan and is rigorously controlled in most other countries. There is growing public concern about possible ill effects on health arising from the consumption of foodstuffs containing sulphur dioxide, so a preservation process which did not require the inclusion of sulphur dioxide would be advantageous.

As a result of continuing research, we have now made the surprising discovery that it is not necessary to use a sulphur dioxide preservative for vegetable foodstuffs and, furthermore, we have found ways of improving the flavour of the preserved product.

According to the present invention, there is provided a method of treating a vegetable foodstuff to preserve it, which method comprises treating the foodstuff in an acid solution of pH 3.8 or less containing one or more non-toxic food acids or other organoleptically acceptable non-toxic acids, the treated foodstuff having a pH of no more than about 4.8, and then sealing the treated foodstuff in a container, the foodstuff having been sterilised by heat and having been blanched.

The method of the invention does not require the use of any sulphur dioxide preservatives and we prefer not to use any. There is generally no advantage in using these preservatives in the present invention.

In the method of the invention, as will be understood by those skilled in the art, the optimum pH of the acid solution will vary for different vegetables and for different sizes of vegetables (or vegetable pieces) being cooked.

In the present specification, we refer to the treatment of vegetable foodstuffs to preserve them. By this we mean extending the shelf-life of the foodstuff. The extended shelf life may be very long indeed or relatively short, but it will always be significantly greater than that

of the untreated foodstuff.

The method of the invention is broadly applicable. Among the vegetable foodstuffs which can be treated by the method of the invention are, for example, potatoes, carrots, beetroot, parsnips, swede turnips, cauliflower, asparagus, artichokes, broccoli, cabbage, corn, celery, peppers, broad beans, haricot beans and butter beans. The foodstuff to be treated may be raw (i.e. uncooked). The invention is particularly (but not exclusively) useful with raw vegetables, especially potatoes which are of large bulk in the quantities used, and consequently great in high energy storage costs.

In the method of the present invention, the vegetable foodstuff is blanched. We prefer to effect blanching simultaneously with the acid treatment by using a hot acid solution. However, a separate blanching step can be used if desired, before the acid treatment, and the acid treatment can then be effected at a lower temperature if desired.

The pH of a macerate of a foodstuff treated in accordance with the invention may generally be no more than about 4.8, the level at which there will be no growth of spores of Clostridium Botulinum or other pathogenic or spoilage organisms. It may be possible with certain vegetables to include salt in an amount such that these organisms will not grow at a slightly higher pH, eg. 5.0. However, it is greatly preferred in the present invention to ensure that the treated foodstuff has a pH no greater than 4.8. The acidity is provided in accordance with a feature of the invention by using one or more food acids or other organoleptically acceptable non-toxic acids. Among the acids which may be used in the acid solution are acetic, tartaric, malic, fumaric, adipic, alginic, ascorbic, citric, hydrochloric and phosphoric acids. These acids are all permitted to be included in Foodstuffs in the Miscellaneous Additives in Foods Regulations 1974 (No. 1121). The

foodstuff may be contacted with the acid(s) before or after the blanching, but it is much preferred to combine the blanching and acid treatment step by blanching in the acid solution itself (with heat).

In the processes described in our British patent specification no. 2174588, the products sometimes suffered from slight flavour loss or masking of the natural flavour by the chemicals used. In accordance with the present invention, we have found that particular acid mixtures are especially advantageous so far as flavour level and penetration of the vegetables are concerned, and the required and most desirable mixture is different for different vegetables. It has also been found that the addition of salt, preferably in small quantities, further enhances the flavour of the vegetables being cooked. Generally, the preferred acid mixture contains tartaric and phosphoric acids, but citric, fumaric, malic, adipic, lactic ascorbic acids may be substituted in total or in part for tartaric acid, and hydrochloric acid in all or in part for phosphoric acid. A particular preferred mixture for the treatment of potato chips comprises in parts by weight about 15 parts tartaric, 15 parts citric, 3 parts phosphoric and 20 parts salt to 100 parts water.

The treated foodstuff is hermetically sealed in a container. Whilst any sort of container can be used, we much prefer to use a heat-sealable thermoplastic material container, because these are convenient and very satisfactory. As will be well understood, the gas and vapour permeabilities of these containers depend on the thermoplastic material(s) used, and the shelf life of the treated foodstuff of the invention will in general be reduced if it is exposed to oxygen permeating into the container. In general, as will be appreciated, we prefer to use very low oxygen permeability materials such as containers made of laminates of nylon and polyethylene, laminates of polyester and polyethylene, and extrusions of

ethylene vinyl acetate copolymer with linear low-density polyethylene, for example. It is possible, of course, to use materials of rather higher permeability such as polyethylene, but this will considerably shorten shelf life. Even lower permeability materials, such as metallised film laminates, can also of course be used but these have the disadvantage of being opaque and thus preventing visual inspection by the purchaser or user of the foodstuff packed therein. Rigid containers made of tinsplate, aluminium or coated board may also be used if desired. In general, the packaging material used will be chosen to provide an adequate shelf life at minimum cost.

To provide the longest shelf life, the treated foodstuff should be sealed in the container in the substantial absence of any oxygen, eg. under vacuum or after flushing the container with another gas. However, where maximum shelf life is not of major importance, then some oxygen can be included in the sealed container.

It is an important feature of the present invention that the blanched acid treated product has been heat sterilised during the process. Sterilisation is a question of time and temperature, i.e. the higher the temperature, the shorter the time required. We normally use a temperature of 90°C to less than 100°C. Sterilisation is necessary to ensure that vegetative cells, yeasts and moulds which otherwise might grow in the pack at the pH level present therein are destroyed. Once the product has been sterilised, it must of course be prevented from being contaminated thereafter. In order to achieve this, we prefer to combine the blanching and acid treatment steps and then to hermetically seal the treated product in a container immediately after it is removed from the hot acid solution before any significant cooling can occur. The combination of heat and the presence of the acid treated foodstuff effectively sterilises the container. Alternatively, the sterilisation of the foodstuff can be effected after the

treated product has been sealed in a container, such as by heating the container in a water bath or by radiant or microwave heating, or in any other suitable manner.

Preferably, the foodstuff is pre-prepared before treating, for example pre-steamed and peeled in the case of beetroot, or peeled and sliced or diced in the case of other root vegetables.

In prior known procedures, it is usual to fill treated vegetables into cans and then add a covering liquid constituting as much as 30 to 35% by weight of the can contents. In the method of the present invention, the use of a covering liquid is not needed and the contents of the container can be 100% edible treated vegetable foodstuff. Furthermore, the use of cans is not essential, and the treated product can be packed under vacuum.

In carrying out the method of the invention, it is convenient to use acidic concentrates for making up the acid solution. A variety of concentrates can be prepared, ready for treating particular vegetables of particular size etc. The concentrates are added to water to make the acid solutions.

Preferably, an acid concentrate is added to the aqueous solution in which the vegetables are to be blanched until that solution is at a pH of from about 2.2 to about 3.8 dependent on vegetable being processed. The solution is heated to 90 to below 100°C, eg. about 95°C and the vegetables are cooked, usually for a period of 7 minutes to 40 minutes, varying according to the vegetable being blanched. During the blanch, further acid is added to the blanch solution such that the pH remains constant throughout the blanch at the level that it was at the beginning of the blanch. In production volumes, this addition is usually made by a dosing pump ejecting acid concentrate into the blancher, the dosing pump being operated by an automatic pH controller. An alternative but less preferred method is to increase the level of acid concentrate to the blanch before

cooking and to add no concentrate during the cooking at such a level as to procure the desired pH in the blanched vegetables. Such a method is suitable for preparing small batches of vegetables, whereas the more preferred method is suitable for the continuous blanching of many vegetables in the same blanching solution. The pH of the solution should have remained constant and the pH of the macerate of the foodstuff particles should not exceed 4.8 and most preferably should be lower. One preferred blanching solution for the making of 12mm potato chips is made by using a concentrate made as follows:

Water	65.3%
Tartaric acid	9.8%
Citric acid	9.8%
Phosphoric acid	2.0%
Salt	13.1%

This concentrate is then added to blanching water at the rate of 9.3ml for each litre of blanching water. For other vegetables, slightly different concentrates and blanching solutions are preferred as illustrated in the Examples hereafter.

The foodstuff, in this case potato chips, is blanched by treatment with water at a temperature above 90°C, but below 100°C, preferably 95°C. It might be possible to blanch at a temperature below 90°C, but the length of blanch required at such lower temperatures to ensure destruction of organisms, i.e. to sterilise, would be such as to make production slow and uneconomic. The blanching time for potato chips is usually 9 to 12 minutes. With other products designed for re-heat in the bag by microwave cooker, when there is very little subsequent re-heat, blanch times should be increased as necessary to ensure that the vegetables are fully cooked at this stage.

In the course of our researches, we have made

another surprising discovery applicable to potato products. If potatoes, chip, dice and whole, are subjected to an extended blanch in water at a lower temperature prior to high temperature acid blanch, then the effect is to remove some reducing sugars and starch from the potatoes. It has been found that if this is done, the concentration of acids in the final blanch may be reduced considerably whilst the pH of blanched potatoes remains the same as in the process previously described. The reason for this surprising effect is believed to be that the well known buffering effect of potato starch is reduced by removing some starches. This may be considered as an alternative method to that described previously - it requires additional plant for blanching, yet saves costs of acids, and by reducing acid concentration in the prepared chips or other potatoes reduces any risk of acid off-flavour in the product. It has the further advantage that when making potato chips, raw potatoes with a higher content of reducing sugars may be used than in the previous method as some sugars are removed in the first blanch. High levels of reducing sugars cause excessive browning in chips when fried.

After hot acid blanching, the vegetable foodstuff is drained and packed hot in heat sealable thermoplastic material, preferably flexible sachets. A high standard of hygiene is maintained during the packing. The thermoplastic material should have suitable properties as hereinbefore described.

Before the packages are heat sealed, they are desirably evacuated and gas flushed with an inert gas such as nitrogen or carbon dioxide or a mixture of the two. For example, sachets of foodstuff may be transferred to a vacuum sealer which is evacuated to a vacuum of 850 mbars, and nitrogen is then flushed into the vacuum until it decreased to 250 mbars.

The package is then heat sealed. For example a sachet may be sealed by impulse heat sealing, two seals on

each sachet being preferred as extra guarantee of integrity. As described previously, if the vegetable foodstuff has not been sterilised during the blanching and acid treatment, it can be sterilised after sealing in the package. (It can, of course, also be sterilised as a separate step immediately prior to packing, if desired.)

In cooking and preserving beetroot, it has been found that a technique is desirable which is somewhat different from that used for other vegetables, in order to soften them to such a degree as to make them edible. We have found that the beetroot are best steamed for one hour to cook, steaming being preferred to water cooking as there is better retention of juices. The cooked beet are then cooled, carborundum peeled and the crowns removed by hand.

In the case of whole baby beetroot, the beet are further cooked in a re-prepared acid solution of 90% water, 10% pre-mix of tartaric and phosphoric acids. The solution has pH of 2.5. The cooking time is 20 minutes at 90°C. After cooking, the beetroot have pH of 3.9 to 4.0. They are transferred to pouches of the same specification as used for potatoes, at a temperature of not less than 90°C. The pouches are evacuated and sealed as previously described.

In the case of sliced beetroot, the roots are steamed as whole beetroot and then passed through a slicer. The pre-mix of solution is reduced to 8.5% to give a pH of 2.8 and the slices cooked for 8 minutes at 90°C, the pH of the solution being maintained at constant 2.8 by the regular addition of the tartaric-phosphoric concentrate during the cook. Approximately 23ml are required for each kilo of beet cooked.

It has been found that there is a particular problem in processing beetroot which has not been found for other vegetables. The problem is the growth of mould in pack. As moulds are totally destroyed at a temperature of 80°C it is believed, and confirmed by examination, that the cause of the problem is the presence of mould spores on the

packaging material. These are not destroyed due to the rapid cooling of the thin pack of beetroot slices. To overcome this special problem a variety of measures have been found to be effective, such as pre-heating empty pouches before filling, sterilizing empty pouches with hydrogen peroxide, passing filled and closed pouches through a radiant heat tunnel for such length of time as to raise the temperature of the contents to 85°C, or passing closed packs through a water bath heated to achieve the same internal pack temperature. The preferred method is to heat the bags before filling either by radiant heat or microwave.

Beetroot prepared by this process have been found to have a better flavour than sterilized vacuum packed beetroot or the short shelf life acetic acid treated chilled beetroot with short shelf life of a few days. Beet treated by the method of the present invention have a life of many months without chilling.

It is an important requirement in the treatment of vegetable foodstuffs to extend their shelf life, that their flavour be altered as little as possible. Virtually all the treatment processes known hitherto have some effect on flavour, and most have a very significant effect. It is a feature of the present invention that, by choosing acids or mixtures of acids from the list given above, treated vegetable foodstuffs can be obtained with very little if any change in flavour as compared with the fresh blanched vegetable. Change in flavour is very easily assessed by making direct comparisons and can be established by routine testing. The invention thus includes an hermetically sealed container within which is a sterile blanched vegetable foodstuff as hereinbefore listed of pH 4.8 or less, having an extended shelf life, and whose flavour is substantially the same as the blanched but otherwise untreated fresh vegetable.

The invention further includes an hermetically

sealed container within which is a sterile blanched vegetable foodstuff of pH 4.8 or less having an extended shelf life, which foodstuff has been treated in an acid solution, the foodstuff and acid being selected from:

potato	tartaric/citric/phosphoric acid mixture
potato	tartaric/citric/acetic acid mixture
potato	tartaric/citric/malic/orthophosphoric acid mixture
carrot	malic/tartaric/phosphoric acid mixture
parsnip	malic/tartaric/phosphoric acid mixture
swede turnip	malic/tartaric/phosphoric acid mixture
cauliflower	malic/tartaric acid mixture
beetroot	tartaric/phosphoric acid mixture

The following Examples illustrate the invention:

EXAMPLE 1

About 18 kg potatoes were peeled, hand trimmed to remove all eyes, passed through a chipping machine to give chips of 12mm cross-section and slivers removed. 10kg of chips were prepared. They were blanched for exactly 9 minutes in a bath heated to a temperature of 95°C and containing, for each litre of water, 13.3mls of a pre-mixed concentrate containing:

Water	65.3%
Tartaric acid	9.8%
Citric acid	9.8%
Phosphoric acid	2.0%
Salt	13.1%

The volume of water for heating 10kg chips is approximately

30 litres. Volume is not critical, but concentration is. During the blanch, 100mls of concentrate was added after 2½ minutes, 5 minutes and 7½ minutes, a total of 300ml. The pH of the blanch solution both before cook and after cook was 2.6. If required, further batches of chips are then prepared in the same blanch solution and make-up added during the cook at the same rates.

After blanching, the potatoes were immediately filled into pouches made of a laminate of nylon and polyethylene. They were then put into a vacuum sealer and evacuated to 980 mbars, nitrogen was then flushed into the pack until the vacuum was reduced to 400 mbars, and the packs were then sealed by a double impulse sealer.

After sealing and resting for 24 hours, the treated potatoes were checked for acidity. The acidity was found to be pH 4.6.

After storage at ambient temperature for 3 months, the potatoes were examined and found to be in perfect condition. Again examined after 6 months, the potatoes had lost some colour when raw, but were found to be equal in quality to fresh after frying.

EXAMPLE 2

10kg potatoes were prepared as in Example 1. The chips were blanched in water at 75°C for 10 minutes. The chips were then transferred to the acid blanch in which they were cooked for 8 minutes at 95°C. The blanch solution contained initially 8.9ml of the same concentrate as in Example 1 for each litre. During the blanch 83ml of concentrate were added after 2 minutes, 4 minutes and 6 minutes, a total of 249ml. The pH of blanch before and after cook was 2.7. It will be noted that the make-up required is 17% less than in Example 1. The acidity of the treated potatoes is 4.6.

Packing and sealing is as in Example 1.

EXAMPLE 3

Potatoes diced to 12mm dice were treated by the process of Example 1 with similar results.

EXAMPLE 4

Potatoes diced to 12mm dice were treated by the process of Example 2 with similar results.

EXAMPLE 5

Potatoes sliced to 4mm thick slices were treated in the same way as Examples 1 and 3, except that the amount of premix was reduced by 20% and the make-up also reduced by 20%. Samples tested after packing were found to have the same level of acid as in the Examples above. Potatoes chipped to 4mm cross section, so called Stringfellow chips, were given the same treatment as sliced potatoes. The results were satisfactory.

EXAMPLE 6

Potato slices and Stringfellow chips as in Example 5 were treated as in Example 2 except that premix in blanching solution was reduced by 20% and make-up was reduced by 20%. The results were satisfactory.

EXAMPLE 7

Potatoes chipped to 20 x 10mm cross section, so called Steak Chips, were treated by the process of Example 1, except that the make-up added to blanch was increased by 10%. The results were satisfactory.

EXAMPLE 8

Potatoes chipped to 20 x 10mm cross section, so called Steak Chips, were treated by the process of Example 2, except that the make-up added to blanch was increased by 10%. The results were satisfactory.

EXAMPLE 9

Example 1 was repeated but using a concentrate without any salt (since some people prefer not to include it for health reasons or because they think that the presence of salt shortens the effective life of frying fat).

The pre-mix of acids was:

Water	67%
Tartaric acid	20%
Phosphoric acid	8%
Acetic acid	5%

The volume of water for heating 10kg of chips is 30 litres. The initial addition of pre-mix is 5ml for each litre of water. During the blanch 70 ml of concentrate was added at 3.6 and 9 minutes, the total length of blanch being 11 minutes. The pH of blanch both before and after cook was 2.7. The treated potatoes had a pH of 4.7. Other procedures were as in Example 1.

EXAMPLES 10 TO 16

Potatoes prepared as in Examples 2 to 8 except that the acid pre-mix was changed to that in Example 9. The results were satisfactory..

EXAMPLE 17

Flash fried potato chips were made. Potato chips were treated as in Example 1 except that the blanching time was reduced to 7 minutes, and concentrate additions were made after 2, 4 and 6 minutes. After blanching, the potatoes were cooled and then fried in a mix of 80% palm oil, 20% rape oil for 1½ minutes at a temperature of 170°C. After the frying, the chips were immediately filled into pouches whilst still hot as in Example 1. Sealing and gas flushing was as in Example 1. The pH of the chips was 4.7.

EXAMPLE 18

Par fried potato chips were made. Chips were treated as in Example 17 except in that the fry was for 3½ minutes at 135°C. The quality of this product after one month storage at 25°C was considered by a taste panel to be equal to that of the popular chilled par fried potatoes which have maximum 21 days life stored at under 5°C.

EXAMPLE 19

Oven chips for preparation by the consumer by cooking in an oven were made. Chips were treated as in Example 17 except that, after the acid blanch, the chips were fried for 5½ minutes at 150°C in the same oil as Example 18, before filling into pouches. After storage for 7 days, a pouch was opened, the chips were spread on an oven tray, and placed in an oven pre-heated to 200°C for 15 minutes. The cooked chips were brown and crisp and considered by a taste panel to be preferable to those of a well known frozen food brand with which they were compared.

EXAMPLES 20 TO 22

Flash fried, par fried and oven chips were made by blanching as in Example 9, followed by frying as in Examples 17,18 and 19. The results were satisfactory.

EXAMPLES 23 TO 36

Examples 10 to 22 were repeated as described except that the potato chips in each case were pre-blanching as in Example 2. The volume of concentrate make-up added during the cook was reduced by 17% from that quoted in each of Examples 10 to 22, to give the same pH in the cooked chips.

EXAMPLE 37

New potatoes, variety Cyprus Champion, graded to a maximum size 45mm, were peeled, and hand trimmed to remove eyes and blemishes. The potatoes were then cooked for 35 minutes at a water temperature of 95°C. Each litre of water contained initially 4.7ml of a pre-mixed concentrate containing:

Water	55%
Tartaric acid	16.6%
Citric acid	11.1%
Malic acid	11.1%
Orthophosphoric acid	6.2%

10kg potatoes were blanched in 17 litres water containing 80ml concentrate. During the blanch, 44.5ml concentrate were added at 7,14,21,28 minutes, a total of 177.5ml. The pH of blanch solution was 2.7 before the process, and when re-tested after the process was the same. A sample of the treated potatoes was macerated and the pH recorded at 4.5.

At the end of the blanch, the hot potatoes were filled into pouches of nylon/polyethylene. The pouches were partially sealed and allowed to stand for 10 minutes before evacuation, flushing with nitrogen gas and final sealing. The reason for this cooling is that potatoes "explode" if vacuum is drawn when they are hot.

EXAMPLE 38

Carrots graded up to 50mm diameter were crowned and peeled. A concentrated acid solution was made (of pH 0.90):

	%
Water	74.00
Malic acid	11.75
Tartaric acid	11.75
Phosphoric acid	2.50

10kg carrots were cooked in a solution of 60 litres of water and 100ml of the above concentrate. The pH of the solution was 3.75. The carrots were cooked for 40 minutes at a temperature of 95°C. During the cook 33ml of concentrate were added at 8,16,24,32 minutes, a total of 132ml of concentrate. At the end of cook, the pH of the solution was still 3.75. The carrots were removed from the cooking solution and transferred to pouches of nylon/polyethylene at a temperature exceeding 85°C. The pouches were evacuated to 960 mbars, flushed with nitrogen to 500 mbars and sealed. After one week at a storage temperature of 25°C, the carrots were found to be of excellent texture and taste and the pH was 4.40. After 8 weeks storage, the taste remained equal to that of fresh carrots.

EXAMPLE 39

Carrots were prepared as in Example 38, then sliced to 2.5mm thick slices. Slices were cooked for 25 minutes at 95°C. 10kg carrot slices were cooked in 62.5 litres of water containing 112ml of the same concentrate as in Example 38. During the cook, 5ml of concentrate were added at 5,10,15,20 minutes, a total of 20ml. At the end of the cook, carrot slices were treated in the same way as the whole carrots of Example 38. The pH of the cooked slices was 4.60.

EXAMPLE 40

Carrots diced 10mm were treated in the same way as the sliced carrots of Example 39, except that 10ml of concentrate was added at 5,10,15,20 minutes, a total of 40ml. The pH of the cooked dice was 4.5.

EXAMPLE 41

Parsnips diced 10mm were treated in the same way as the carrot dice of Example 40 with satisfactory results.

EXAMPLE 42

Swede turnip was prepared and processed in the same general manner as for the diced carrot in Example 40. The resulting treated product was satisfactory.

EXAMPLE 43

A mixture of diced carrots, parsnips and swede turnips, the so called "Stew Pack", was prepared and packed as Example 40.

EXAMPLE 44

Pre-prepared cauliflower florets were washed in running water. 1kg cauliflower florets were cooked for 10 minutes in a solution of:

Water	4 litres.
Glycerine	140 grams
salt	80 grams
Malic acid	7 grams
Tartaric acid	6 grams

The pH of that solution was 2.6. After the cook, the florets were transferred at a temperature exceeding 90°C to pouches, which were then evacuated, gas flushed and sealed. The pH of the treated florets after storage was 4.50.

EXAMPLE 45

Whole beetroot were graded up to 45mm diameter and steam cooked for 60 minutes and allowed to cool. The skins were removed by a carborundum peeler, and coarse crowns were removed by hand.

A concentrated pre-mix was prepared:

	%
Water	59
Salt	11
Tartaric acid	18
Phosphoric acid	12

2kg prepared beet were cooked for 20 minutes at 90°C in solution of 4.4 litres water and 40ml of concentrate. During the cook, 8ml of concentrate were added to the cooking solution at 5.9, 13.18 minutes which

maintained a constant pH of 3.5 in the solution. The beetroot were then filled four to a nylon/polyethylene pouch 120mm x 120mm, of high oxygen barrier material. The temperature of the beet exceeded 85°C at time of fill. The pouches were transferred to a vacuum machine, evacuated to 960 mbars and flushed with nitrogen to 600 mbars followed by double sealing. The treated beetroot had a pH (macerate) of 4.2.

EXAMPLE 46

Beetroot were steamed and peeled as whole beet, and then sliced to 60mm diameter, 4mm thick. The slices were cooked in a solution of 4kg water and 35ml of the same concentrate as used for whole beet for each 1kg of slices cooked. The cooking time was 8 minutes at 90°C. During the cook, 23ml of concentrated make-up were added at regular intervals to maintain the solution at a regular pH of 2.8. The slices were filled, packed and sealed as whole beet. The pH of the treated slices was 4.2.

EXAMPLE 47

10 kg potatoes were peeled, hand trimmed to remove all eyes, passed through a chipping machine to give chips of 10mm cross-section and slivers removed. The potato chips were then blanched for exactly 7 minutes in a bath heated to a temperature not to exceed 95°C and not to be less than 85°C and which contained for each litre of water, 8.3 ml of a premix as follows:

water	72.5 ml
phosphoric acid	10 ml
tartaric acid	17.5 ml

The pH of the resulting blanching solution was 2.4.

After blanching, the potatoes were immediately filled hot into pouches made of a laminate of nylon and polyethylene. They were then put into a vacuum sealer and evacuated to 28mm of mercury, a mixture of carbon dioxide and nitrogen (50:50) flushed into the packs until the vacuum was reduced to 4mm, and the packs were then sealed by a double impulse sealer.

After sealing, sample packs were checked for acidity. The acidity was found to be in the range 4.6 to 4.8 pH.

After storage at ambient temperature for 3 months the potatoes were examined and found to be in perfect condition. Again examined after six months the potatoes had lost some colour when raw, but were found to be equal in quality to fresh after frying.

EXAMPLE 48

Potatoes diced to 10 mm dice were treated by the process of Example 47, with similar results.

EXAMPLE 49

Potatoes sliced to 4mm thick slices were treated in the same way as in Examples 47 and 48, except that the amount of premix was reduced by about 20%. Samples tested after packing were found to have the same level of acid as in Examples 47 and 48 above. Potatoes chipped to 4mm cross-section, so called Stringfellow chips, were given the same treatment as sliced potatoes.

EXAMPLE 50

Potatoes chipped to 20 x 10mm cross-section, so-called Steak Chips, were treated by the process of Example

47, except that the amount of premix used was increased by about 10%. The results were as in Example 47.

EXAMPLE 51

Whole carrots graded from 20mm to 30mm diameter of variety Chanteney Red Cored were used. 10 kg of carrots had the crowns removed, were peeled in a carborundum peeler and then blanched for 20 minutes in water at 95°C, and containing for each litre of water 3 ml of the premix defined in Example 47. The pH of the solution was 2.61.

After hot soaking, the carrots were immediately packed in a carbon dioxide nitrogen atmosphere by the same method as used for the potatoes.

EXAMPLE 52

Carrots sliced to 3mm thick slices were treated in the same way Example 51 except that the amount of premix was 7.5 ml and this was added to 2.8 litre water to make an acidic blanching solution of pH 3.15.

EXAMPLE 53

Parsnips were prepared by the same method as carrots in Example 51, diced in 10mm dice, and blanched and packed in the same way.

EXAMPLE 54

Swede turnip was prepared and processed in a similar manner to carrots in Example 51.

EXAMPLE 55

Pre-prepared cauliflower florets were washed

carefully in cold running water. They were then blanched for three minutes in a solution containing, for each litre of water, 4 ml of the premix described in Example 47. The pH was 2.92.

Blanching temperature was 95°C. The florets were then immediately packed hot in pouches which were processed by the same method as described for potatoes (Example 47).

CLAIMS:

1. A method of treating a vegetable foodstuff to preserve it, which method comprises treating the foodstuff in an acid solution of pH 3.8 or less which solution contains one or more non-toxic food or other organoleptically acceptable acids, the treated foodstuff having a pH of no more than about 4.8, and then sealing the treated foodstuff in a container, the foodstuff having been sterilised by heat and having been blanched.
2. A method according to claim 1, which is effected without using any sulphur dioxide preservative.
3. A method according to claim 1 or 2, wherein the acid solution is a mixture of acids containing one or more of acetic, alginic, tartaric, malic, fumaric, adipic, ascorbic, citric, hydrochloric and phosphoric acid.
4. A method according to claim 3, wherein the acid solution contains tartaric acid and phosphoric acid.
5. A method according to any of claims 1 to 4, wherein the acid solution also contains salt.
6. A method according to any of claims 1 to 5, wherein the vegetable foodstuff is blanched in the acid solution.
7. A method according to claim 6, wherein the acid solution is heated to from about 90°C to less than 100°C and the vegetable foodstuff is blanched therein for from 7 to 40 minutes, the pH of the solution being maintained at from 2.2 to 3.8 throughout the period.

8. A method according to claim 4, wherein the vegetable foodstuff is raw potato and the acid solution comprises by weight 15 parts tartaric acid, 15 parts citric acid, 3 parts phosphoric acid and 20 parts salt in 100 parts water.
9. A method according to any of claims 1 to 8, wherein the vegetable foodstuff is raw potato and the potato is first blanched at a low temperature and then blanched in the acid solution at a higher temperature.
10. A method according to claim 7, wherein the vegetable foodstuff is beetroot.
11. A method according to claim 10, wherein the beetroot is first cooked by steaming, and is then treated in heated acid solution.
12. A method according to any of claims 1 to 7, wherein the treated foodstuff is hermetically sealed in a thermoplastic material container.
13. A method according to any of claims 1 to 12, wherein the container is evacuated and then flushed with an inert gas before sealing the treated foodstuff therein.
14. A hermetically sealed container having therein a vegetable foodstuff which has been treated by the method of any preceding claim.
15. A hermetically sealed container within which is a sterile blanched vegetable foodstuff selected from potatoes, carrots, beetroot, parsnips, swede turnips, cauliflowers, asparagus, artichokes, broccoli, cabbage, corn, celery, peppers, broad beans, haricot beans and butter beans; the said foodstuff having a pH 4.8 or less and having an extended shelf life, and whose flavour is substantially the same as the blanched but otherwise untreated fresh vegetable.

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16. A hermetically sealed container within which is a sterile blanched vegetable foodstuff of pH 4.8 or less having an extended shelf life, which foodstuff has been treated in an acid solution, the foodstuff and acid being selected from:

potato	tartaric/citric/phosphoric acid mixture
potato	tartaric/citric/acetic acid mixture
potato	tartaric/citric/malic/orthophosphoric acid mixture
carrot	malic/tartaric/phosphoric acid mixture
parsnip	malic/tartaric/phosphoric acid mixture
swede turnip	malic/tartaric/phosphoric acid mixture
cauliflower	malic/tartaric acid mixture
beetroot	tartaric/phosphoric acid mixture

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 A23B7/10;

A23B7/148;

A23B7/06

II. FIELDS SEARCHEDMinimum Documentation Searched⁷

Classification System

Classification Symbols

Int.Cl. 5

A23B

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched⁸**III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹**

Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	EP,A,0 201 266 (J. G. HOWARD ET AL.) 12 November 1986 & GB 2174588 cited in the application see the whole document	1-7, 10, 12-16
Y	PATENT ABSTRACTS OF JAPAN vol. 15, no. 197 (C-833) 21 May 1991 & JP,A,30 53 845 (J. KUROKI ET AL.) 7 March 1991 see abstract	1-7, 10, 12-16
X	FR,A,2 401 065 (THE MEAT CORP.) 23 March 1979 see the whole document	1-3

¹⁰ Special categories of cited documents:^{"A"} document defining the general state of the art which is not considered to be of particular relevance^{"E"} earlier document but published on or after the international filing date^{"L"} document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)^{"O"} document referring to an oral disclosure, use, exhibition or other means^{"P"} document published prior to the international filing date but later than the priority date claimed^{"T"} later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention^{"X"} document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step^{"Y"} document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.^{"A"} document member of the same patent family**IV. CERTIFICATION**

Date of the Actual Completion of the International Search

24 AUGUST 1993

Date of Mailing of this International Search Report

A. 02. 93

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

GUYON R.H.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	<p>DATABASE WPI Derwent Publications Ltd., London, GB; AN 92-092854 & JP,A,4 036 142 (M. NOMURA.) 6 February 1992 see abstract</p> <p>----</p>	1-3,6,7, 10,12, 14,15
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X	<p>DATABASE WPI Derwent Publications Ltd., London, GB; AN 83-52421K & JP,A,58 067 145 (AIZU TEMPO JOZO) 21 April 1983 see abstract</p> <p>----</p>	1-3,6,7, 12,14,15
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300691
SA 73092

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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24/08/93

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